White Paper Report

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Institution: Juneau-Douglas City Museum

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PF-50253

An Energy Efficient Climate Control System for the Juneau-Douglas City Museum

Jane Lindsey, Project Director
Juneau-Douglas City Museum

May 20, 2015

Project Activities

The goals of the Juneau-Douglas City Museum energy efficient climate control system upgrade included: a) Protecting and stabilizing the historic Juneau community collection that the Museum houses; b) Protecting the historic integrity of the building listed on the national register of historic places in which the Museum resides; c) Realizing energy efficiency through installation of a renewable energy resource system.

Housed in the first library built by public funds in Alaska in 1951, as a territory of the United States, the Juneau-Douglas City Museum's building is listed on the national register of historic places for the official 49-star flag raising ceremony when Alaska achieved statehood in 1959. Since initial construction, the facility had not undergone upgrades to its 1951 oil-fired boiler heating system and contained no integrated ventilation and air cooling. Since residency in the building in 1989, the Museum has systematically and incrementally worked to maintain collections best practices. Environmental data confirmed collections, storage and exhibit areas were too dry in the winter and, increasingly, too warm with unacceptable levels of humidity in the summer. With no ventilation system, each year, we were forced to prop open doors and windows in the bathrooms and video room to allow air flow into the building and provide minimal visitor comfort. Opening doors and windows mitigated high levels of humidity, dust and dirt into the building and compromised security issues in the facility.

Our material collection includes the only known in-tact basketry style fish trap on the pacific northwest coast; the only surviving records of the city of Douglas; the most complete set of local newspapers from the Juneau area beginning with the Douglas Island News in 1898 through the 1950s; and photos and archives from the Juneau Volunteer Firefighters Association, 1887-1987, which are the only known collection that documents the development and destruction of much of Juneau's built environment. Settled in the 1880s and one of the last territories to become a state, the Museum collection preserves families, businesses, civic and cultural life in an isolated geographical region. Our story is one of a community that transitioned from a Tlingit summer fish camp, to a mining camp, to the first incorporated city in Alaska, to the largest hard rock mining operation of its time, to Alaska's territorial and now state capital that gleans economic benefits from long-established tourism and fisheries.

Pre-planning for system upgrades was preceded by a 2007 Museum assessment, design and remodel project. This plaining project weighed many options for our 6500 sq. ft. historic building by facility and museum professionals. The City and Borough of Juneau pledged a 1:1 grant match for the energy efficient climate control system upgrade NEH grant application. When the grant funds were awarded, the city awarded funding for additional upgrades to further improve building comfort and energy performance. Due to the presence of hazardous materials, the project included abatement services.

EHS-Alaska, Inc. Engineering, Health and Safety Consultants were contracted to conduct a Hazardous Materials Survey of the building and issued a report on June, 3, 2013. Also in June, Jim Rehfeldt, P.E. of Alaska Energy Engineering LLC as sub consultant to PDC Engineers performed a cost analysis of four options of heating and ventilation for the building in order to establish a baseline for energy-efficient performance: Fuel Oil Boiler & Air Handling Unit; Electric Boiler & Air Handling Unit; Wood Boiler & Air Handling Unit; Variable Refrigerant Flow Heat Pump & Dedicated Outdoor Air System. It was determined that variable refrigerant flow heat pump & dedicated outdoor air system, also known as air source heating would be the best cost effective retrofit for our building and allow us to achieve renewable energy efficiency with hydroelectric power.

The original oil fired boiler system was removed and replaced with a dedicated outside air system (DOAS) heat recovery ventilator (HRV) that includes a heating and cooling coil to provide space conditioning and dehumidification plus six condensing units installed outside the existing boiler room behind the building. Heating and cooling distribution is delivered to fifteen Fan Coil Units (FCU) placed in independent zones throughout the Museum. The refrigerant distribution system consists of a two pipe system with aluminum refrigerant liquid and suction lines, insulated with ½" thick closed cell foam. Heat is recovered through a polymer core type heat exchanger that recovers both latent and sensible heat and helps stabilize humidity control. A new control system is integrated with the heating and cooling system providing a high level of terminal unit control to maintain space comfort. Additional local electronic controls have been provided at the DOAS unit to modulate and monitor the ventilation fans and associated equipment. Electric base board heaters were installed in the two toilet rooms, and storage closet located in the basement.

Design Criteria was based on International Building, Mechanical, and Plumbing codes, plus American Society of Heating, Refrigerating and Air-Conditioning Engineers Standards 90.1 and 62, National Fire Protection Association, and Installation of Air-Conditioning and Ventilation Systems. The following relevant design parameters for this project are Design Climatological Data (ASHRAE Fundamentals 2009, chapter 14, Juneau, AK), plus Summer and Winter Design Data.

Design specifications by Design Consultant Engineer, Danny Rauchenstein of PDC Inc.:

- **Daikin** is the manufacturer of all interior Fan Coil Units wall or floor mounted, VRF heating and cooling with integral controls, local low-voltage thermostats, DDC system connections, condensate pumps and enclosures.
- **Daikin** is manufacturer of all exterior Condenser Units, air cooled VRF condensers with self-diagnostic function.
- **Renewaire** is manufacturer of Heat Recovery Ventilator,
- **Dristeem Vaporsteam** is manufacturer for Electric Steam Humidifier, and
- **King** is manufacturer for Electric Baseboard.

Electric work for this project required a transformer upgrade with underground conduit to the facility. Also installed was a new utility service exterior distribution panel which has disconnects re-supplying the existing service and the new heat-pump system. New branch circuits were provided to new mechanical equipment.

During the demolition phase, the drop ceiling in the basement was removed, and new light fixtures were installed along with a new source extraction snorkel hood with an articulating arm connected to the HRV exhaust for proper exhibit and label production work space ventilation. Six single paned windows were removed and replaced with new double paned windows; two exterior doors were removed and replaced with new steel doors. A total of four new windows were replaced in the upper level, staff office, and two new windows in the toilet rooms. The two exterior doors replaced are located in the basement.

Project start-up delays moved the construction start date to May 1, 2014. The Museum was nose to nose with its summer season, its busiest time of the year. With the summer season approaching and exhibit change-outs scheduled, the need to generate income had to be negotiated with the project. In April, our contractor, Wolverine Services, LLC, conducted a pre-construction walk-through with Far North Services, the abatement contractor. It was determined that we were able to leave our dedicated and oversized collections located in the basement in place, and per the final design of the air-source

heat pump system and chase retrofits in the Museum gallery, Wolverine Services felt confident that one month of closure in May would be enough time to accomplish abatement and dedicated work in the Museum gallery located on the first floor of the building. The Museum could open to the public June, through August, and complete the project while galleries were open to the public. Museum staff occupied the third floor office area, open the galleries to the public, and allow the bulk of the construction to take place in the basement.

This new work plan required an alert, positive and resilient attitude from staff, our City Engineering project consultant, Theresa Mores, and our onsite Wolverine Services general contractor, Stuart Dunham. We hired a moving company to pack non-collections related items from the basement and move boxes into three city owned, secured, office spaces in an offsite location. The Museum set up a temporary off-site work office for our Curator of Collections so she could continue to process collections, supervise collections volunteers, and complete exhibit production in a space suitable for these activities. On-site, two additional work desks were set up in the upstairs office that normally seats three staff. Because no sensitive items needed to be moved offsite, the services of a conservator were minimized for this activity. Museum staff remained close to objects and monitored them daily and through the course of the construction. Prohibited access to collections happened only when hazardous materials abatement was underway in the basement from May 1-15, 2014. Staff remained onsite to talk to the team and the general contractor each day about the project. A plus, our general contractor, Wolverine Services, remained onsite for the duration of the project which helped foster trust and consistent communication as sub-contractors came and went. The Director attended construction progress meetings every two weeks with project personnel. The city engineering project consultant produced construction observation reports and submitted them to all parties weekly that continued clear communication about the progress and questions related to the project.

When we evacuated remaining oil in our tank and turned off the 1951 Birchfield oil boiler at the beginning of May, the building temperature dropped dramatically. All the years that we used our oil boiler in the Museum, every year in April or May we would turn off the circulation pump. The general conclusion being that turning off the heat pump resulted in minimal heat production. With complete demolition and removal by the abatement crew, we quickly realized very cool temperatures in the museum ranging as low as 60-62 degrees. We quickly set up space heaters for the galleries when we opened to the public June. Had the project begun in the fall and winter as originally scheduled, we most likely would have run into even lower temperatures that may have caused additional facility problems. As the project progressed, we were able to keep heat at an acceptable level but then experienced the rainiest summer in August in seventy years. High humidity during the rainiest summer in our history required us to set-up and run de-humidifiers in dedicated collections storage the galleries. Considering these unpredictable temperature swings during construction, for the first time in over a decade, the building was not overheating during the summer and the Museum was able to keep all outside doors and windows closed at all times.

Museum construction took place May through mid-September with various impacts on visitation and staff depending on what phase of construction we were in. For several months, staff and the custodian came in from 6am-9am to allow dedicated two-hour core drilling through cement for chase work and system connection in the basement and the gallery. If most of the drilling was in interior walls we were fine with work commencing during extremely early hours. The general contractor was cognizant about pre-planning for gallery construction and clean-up, and working in stages, so we could offer visitors a comfortable experience. We had very few instances when we needed to block off an entire gallery or disrupt visitor access to our exhibits. We kept volunteers updated and asked them to explain to visitors

what kind of construction was happening and what they might experience as they toured the Museum before they purchased admissions.

The Director spent dedicated time with the general contractor looking at slow visitor times in the day, based on weekly cruise ship trends so drilling and gallery de-installation and installation could occur at these times. Since our local larger state run museum was closed for construction of their new facility, we saw a healthy interest in our Museum and realized an attendance of 8697 visitors during our construction time including the closure in May and several days in August for electrical transformer upgrades.

Delays in the project occurred when the 1000 gallon, 1951 oil tank was removed from the ground and contaminated oil soaked soil was identified. Our hazardous survey report stated that this was a possibility due to the age of the tank and the practice at the time of installation of burying them in the ground. The State of Alaska Department of Environmental Conservation consultant came immediately to the site and CBJ project coordinator, Theresa Mores worked with the State and the contractors to remove contaminated soil, test it, and wait for paperwork clearance on the project. This situation is all too common here in Juneau and Alaska where we primarily use oil for heating. The buried tank was within 6 yards of an accessioned 1967 totem pole that sits on the site. Staff monitored work continually to ensure that no work or equipment came to close to our totem pole.

Unexpected project delays resulted in the heating coil for the de-humidification system not being UL listed and ready for install as scheduled. A supplier issue, the system is able to keep humidity at a stable level due to the introduction of a circulating air system that dries air out. Through daily monitoring, our set point of 40%RH +/-10% is being achieved. The coil is needed for de-humidification, not humidifying which is our biggest need in the winter when collections are too dry. De-humidification is needed during our rainy summer months. The coil is expected no later than June 2015. City project consultant, Theresa Mores is working with the designer to ensure that this issue is resolved satisfactorily.

Evaluation

Alaska State Museum (ASM) conservator Ellen Carrlee conducted a site visit August 8, 2014 with follow up email on October 10. Her comment on our internal environment, “Regarding the grant... As you settle back in now post renovation, it might be good to discuss placement of data loggers and if the ASM might need to lend a few extra data loggers to make sure the different areas of the building are doing what we think they are. A couple of thoughts… When the HVAC system tells you what your RH is, where are those sensors located? We can compare the info the system gives us with what your objects are experiencing, but if there is a discrepancy sensor placement is sometimes the reason. Otherwise, one or the other monitoring device gets blamed for the difference in readings.”

The system humidistat is located at the base of the trunk line return to the heat recovery unit and monitors all air that is collected before heat recovery. Because the entire building is so small, approximately 6500 sq. ft., engineers advised that we would not experience micro-climates. However, Carrlee’s advice was noted and the Museum bought and placed three additional dataloggers in three of our galleries monitor temperature and humidity. For ongoing project evaluation and object care we have four dataloggers independently monitoring our new system in our 2500 sq. ft. gallery space. Three dataloggers are also located in the basement (also about the same size as the gallery but more open): processing room, compact storage, and large object storage.

Museum concerns about system placement and protection of artifacts and artifacts on exhibits have centered on ensuring that wall mounted units placed close to collections and in galleries have appropriate air flow so that warm and cool air don't blow directly onto storage areas or artifacts. We have worked to ensure a balance between leaving space open/free because of air flow activity and utilizing space for necessary collections storage and exhibit needs. We have the ability to direct air flow through unit louvers (straight out, down, oscillating) to ensure the best direction for each unit based on where it is and what is near it.

The stabilization of the Museum's temperature and humidity by this new system will provide long-term benefits for our collection monitored through time. Many pieces of contemporary art undergo an acclimation process as they age. With stable temperature and humidity this process will be easier on the work preventing damage such as delamination and splitting, as has seen in our *Diving Raven* spruce trail marker carved by Rick Beasley in 2006 (JDCM 2008.05.001) and *A Worm in Each and Every One* painted by John Stoll in 2006 (JDCM 2006.47.001), respectively. The humidity set points will help prevent curling of paper and photographic artifacts, help combat mold growth, prevent condensation on our glass artifacts, and keep our wooden artifacts from swelling and constricting with the weather, among other benefits. The temperature stabilization has similar benefits to our collection and exhibits. Cooler temperatures in storage will help preserve our extensive photographic negative collection. Additionally, the climate stabilization the system provides allows the City Museum to maintain security of our collection both in storage and on exhibit through the elimination of the need to open doors and windows to provide air flow.

We expect that until we receive and install our de-humidifier coil we will experience RH fluctuations, but expect them to be within 40%RH +/-10%.

Air-source heat pumps are relatively new to Southeast Alaska and there is a concern that under very cold temperatures they don't operate as well. Juneau is known as a temperate rain forest and our mechanical contractor has advised us that the problems he has experienced with them are due to improper installation through setting the condensers directly on the ground. Our condensers have been installed with an 8" clearing that allows possible ice and snow build-up on the ground during winter months.

In monitoring energy costs, the Museum spent approximately $20,000 each year on both electric and heating oil, with some fluctuation year to year dependent of utility prices and season temperature extremes. At system design, our project engineers calculated approximately $20,000 a year or less to run our new system based on 179,222 kw/yr. "The life cycle cost analysis performed has nothing to do with the building lighting and power (wall plug in)…As noted, any new system will use more energy to run and is replacing essentially fans and outside air. We are optimistic that this system, including lights will stay at $20,000 or less."

<u>Continuation of the Project</u>

To date, based on actual system readings from October to May, kw usage per month have allowed the Museum to estimate 115,000 kw per year and take down fiscal year 2015 projections to $14,000 a year, a savings of $6,000 yearly over past usage costs when there was integrated heating, ventilation, and air-cooling system. We look forward to collecting more data to understand long term trends and are encouraged by these reports.

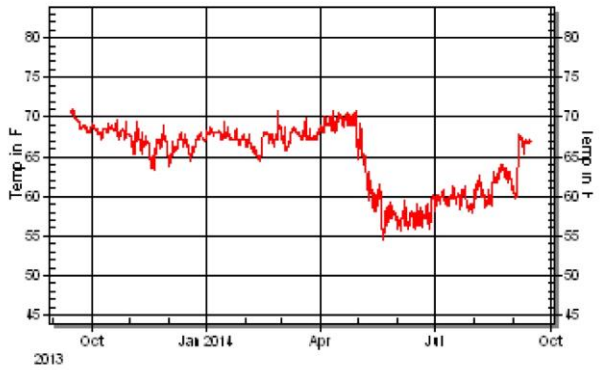
Daily readings since project completion achieved on September 15, 2014- End of May, 2015 show that our heating, ventilation, and humidity retrofit is operating at our target goal of acceptable relative humidity range of 40%RH +/-10%, and temperatures of 68°+/-4°. We are eager to track environmental data and energy usage to evaluate big picture trends in both the environmental system and energy consumption.

At report end we are satisfied with the results of this project as we work to monitor long term trends and object stability. We believe that project goals a) Protecting and stabilizing the historic Juneau community collection that the Museum houses; b) Protecting the historic integrity of the building listed on the national register of historic places in which the Museum resides; c) Realizing energy efficiency through installation of a renewable energy resource system have been met.

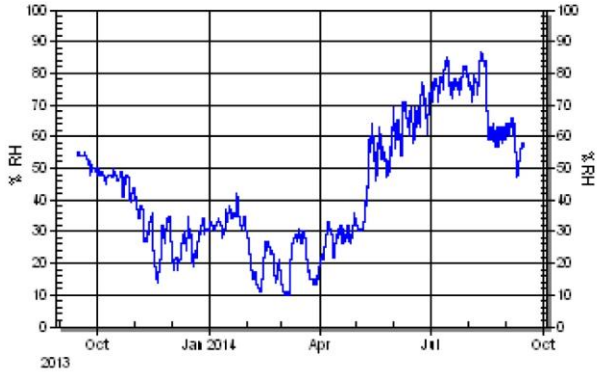
<u>Environmental Datalogger Comparison Reports to date:</u>

Basement – Collections Storage (pre-system installation)
Graph for September 15, 2013-September 15, 2014

Temperature



Relative Humidity



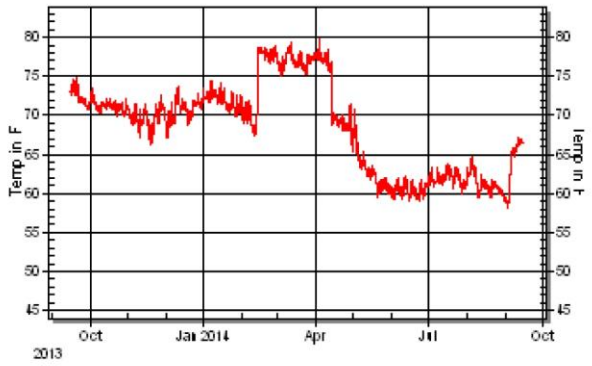
Graph for September 15, 2014-May 15, 2015 (system performance)

Temperature

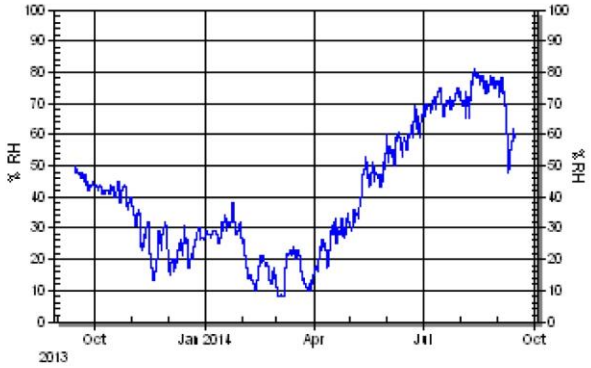
Relative Humidity

Basement – Large Object Storage (pre-system installation)
Graph for September 15, 2013-September 15, 2014

Temperature



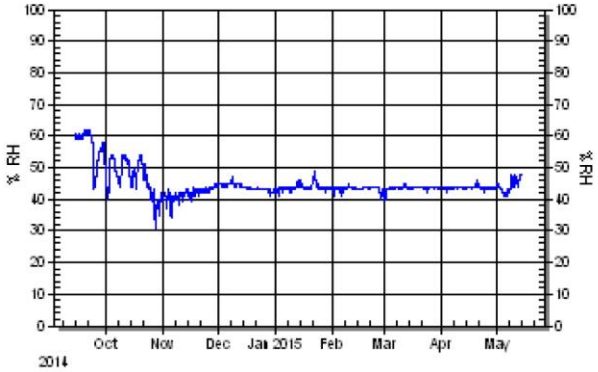
Relative Humidity



Graph for September 15, 2014-May 15, 2015 (system performance)

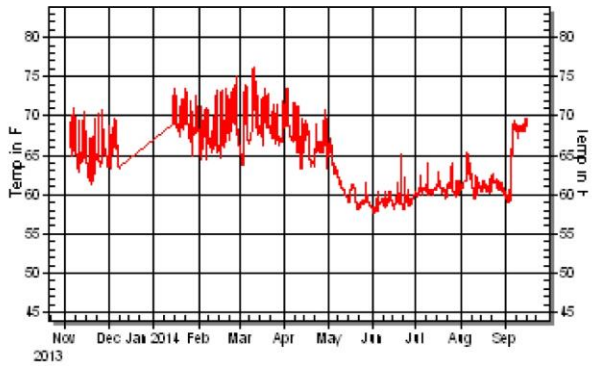
Temperature

Relative Humidity

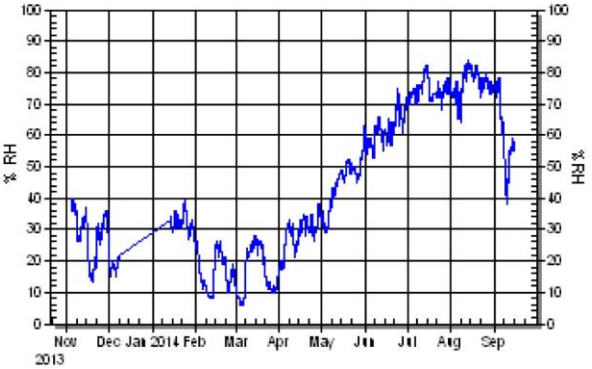


Basement - Collections Processing Room (pre-system installation)
Graph for September 15, 2013-September 15, 2014

Temperature

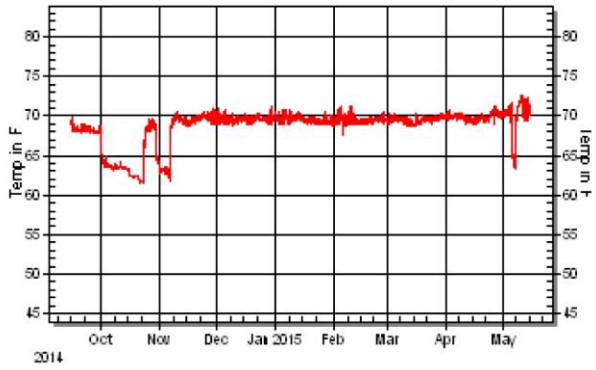


Relative Humidity

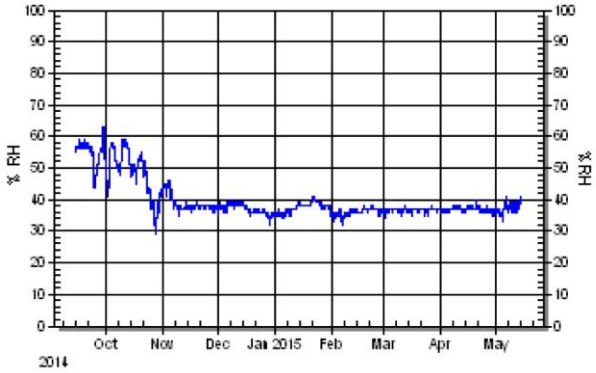


Graph for September 15, 2014-May 15, 2015 (system performance)

Temperature



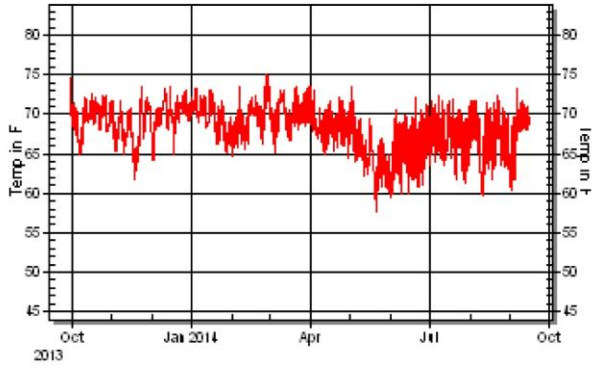
Relative Humidity



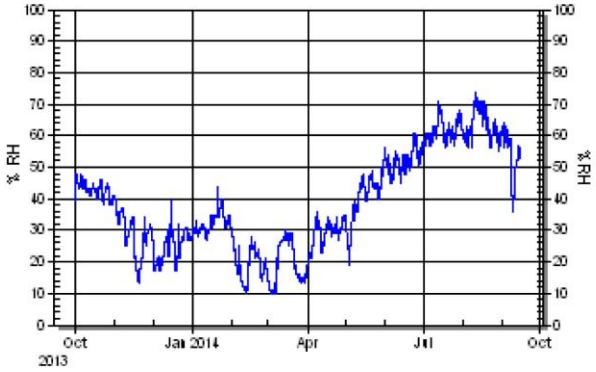
Reception (pre-system installation)

Graph for September 15, 2013-September 15, 2014

Temperature

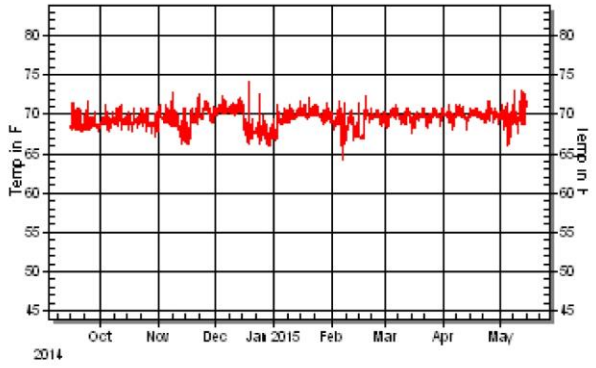


Relative Humidity

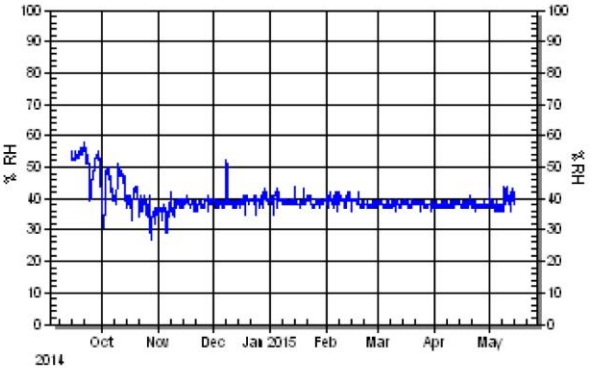


Graph for September 15, 2014-May 15, 2015 (system performance)

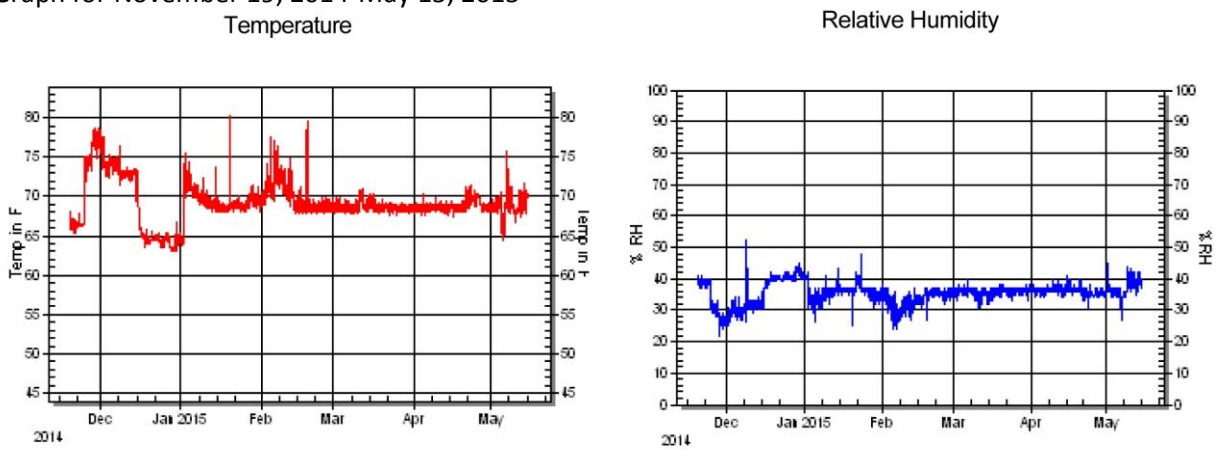
Temperature



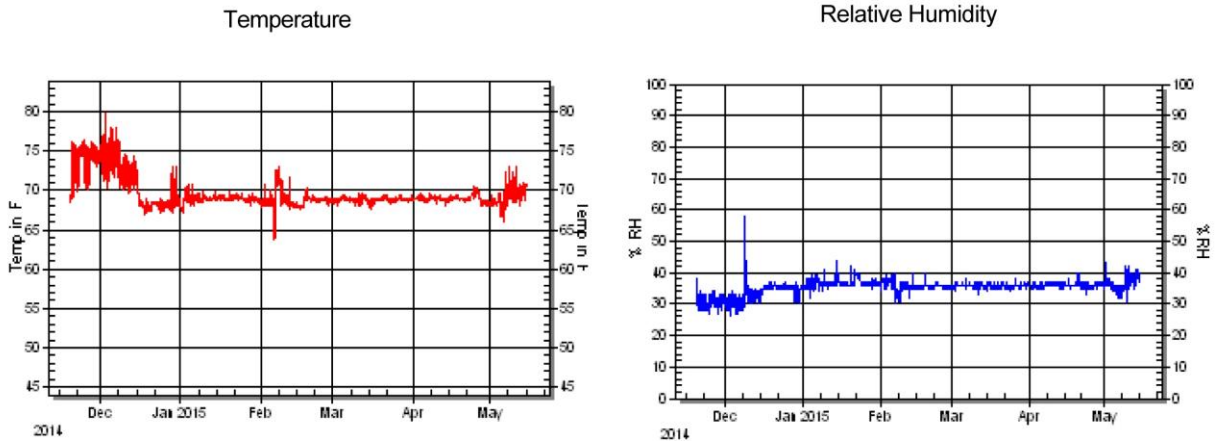
Relative Humidity



Video Gallery, new datalogger installed (system performance)
Graph for November 19, 2014-May 15, 2015



Politics Gallery, new datalogger installed (system performance)
Graph for November 19, 2014-May 15, 2015



General History Gallery, new datalogger installed (system performance)
Graph for November 19, 2014-May 15, 2015